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| 10/054,543 | 01/18/2002 | Ying-Chang Liang | 1085-041-PWH | 9245 |

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| EXAMINER | |
|---|---|
| WARE, CICELY Q | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2634 | |

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Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Sn

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/054,543 | LIANG ET AL. | |
| | Examiner | Art Unit | |
| | Cicely Ware | 2634 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on _18 January 2002_.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) _1-45_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) _24-28,30,44 and 45_ is/are allowed.

6)☒ Claim(s) _1-9,12-14,31,33-37 and 39-43_ is/are rejected.

7)☐ Claim(s) _10,11,15-23,29,32 and 38_ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on _18 January 2002_ is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Drawings*

1. The drawings are objected to because:

a. Fig. 2, examiner suggests applicant delete the floating "g(" for clarification purposes. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

### *Specification*

2. The abstract of the disclosure is objected to because:

a. Pg. 52, line 19, examiner suggests applicant delete this line.

b. Pg. 10, examiner suggests applicant insert a "drawings" heading for clarification purposes.

c. Pg. 19, examiner suggests applicant insert equations (10) and (11) for clarification purposes.

d. Pg. 19, line 21, examiner suggests applicant re-write this line for clarification purposes.

Correction is required. See MPEP § 608.01(b).

### *Claim Rejections - 35 USC § 103*

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-3, 5-7 rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (Fig. 1) in view of Sampath et al. (IEEE, Pre-Equalization for MIMO Wireless Channels with Delay Spread).

(1) With regard to claim 1, Applicant's Admitted Prior Art discloses in (Fig. 1) a method of achieving transmit diversity gain for frequency selective fading channels in a communication system having a base station with multiple transmit antennae (1, 2) and

a mobile terminal with at least a single receive antenna (4), the method comprising the steps of: providing a signal to be transmitted s(n); space-time encoding the signal s(n) (3) to produce at least two separate signals s.sub.1(n),s.sub.2(n), each on a respective output.

However Applicant's Admitted Prior Art does not disclose feeding each output signal s.sub.1(n),s.sub.2(n) to a zero-forcing pre-equalizer having a respective function g.sub.1(k), g.sub.2(k) to produce an output signal x.sub.1(n),x.sub.2(n); feeding the output signal x.sub.1(n),x.sub.2(n) of each pre-equalizer to a transmit antenna; transmitting the output signals x.sub.1(n),x.sub.2(n) over respective physical channels h.sub.1(k), h.sub.2(k); receiving the output signals x.sub.1(n),x.sub.2(n) at least a single receive antenna; space-time decoding the received signals, wherein the functions g.sub.1(k),g.sub.2(k) of the zero-forcing pre-equalizers are selected such that the channel responses g.sub.1(k)*h.sub.1(k),g.sub.2(k)*h.sub.2(- k) of the respective physical channels h.sub.1(k),h.sub.2(k) are flat fading channels.

However Sampath et al. discloses in (Fig. 1) feeding each output signal s.sub.1(n),s.sub.2(n) to a zero-forcing pre-equalizer having a respective function g.sub.1(k), g.sub.2(k) to produce an output signal x.sub.1(n),x.sub.2(n); feeding the output signal x.sub.1(n),x.sub.2(n) of each pre-equalizer to a transmit antenna; transmitting the output signals x.sub.1(n),x.sub.2(n) over respective physical channels h.sub.1(k), h.sub.2(k); receiving the output signals x.sub.1(n),x.sub.2(n) at least a single receive antenna. space-time decoding the received signals, wherein the functions g.sub.1(k),g.sub.2(k) of the zero-forcing pre-equalizers are selected such that the

channel responses g.sub.1(k)*h.sub.1(k),g.sub.2(k)*h.sub.2(- k) of the respective physical channels h.sub.1(k),h.sub.2(k) are flat fading channels (Pg. 1176, col. 2, lines 39-41, Pg. 1177, col. 1, lines 47-49, Pg. 1178, col. 1, lines 4-10, 14-22, 41-43).

Therefore it would have been obvious to one of ordinary skill in the art to modify Applicant's Admitted Prior Art to incorporate feeding each output signal s.sub.1(n),s.sub.2(n) to a zero-forcing pre-equalizer having a respective function g.sub.1(k), g.sub.2(k) to produce an output signal x.sub.1(n),x.sub.2(n); feeding the output signal x.sub.1(n),x.sub.2(n) of each pre-equalizer to a transmit antenna; transmitting the output signals x.sub.1(n),x.sub.2(n) over respective physical channels h.sub.1(k), h.sub.2(k); receiving the output signals x.sub.1(n),x.sub.2(n) at least a single receive antenna; space-time decoding the received signals, wherein the functions g.sub.1(k),g.sub.2(k) of the zero-forcing pre-equalizers are selected such that the channel responses g.sub.1(k)*h.sub.1(k),g.sub.2(k)*h.sub.2(- k) of the respective physical channels h.sub.1(k),h.sub.2(k) are flat fading channels in order to significantly reduce the equalizer complexity in the mobiles (Sampath et al., Pg. 1175, col. 1, lines 57-60).

(2) With regard to claim 2, claim 2 inherits all the limitations of claim 1. Sampath et al. further discloses wherein the communications system is a time-division duplex system and the method includes the further step of deriving the real channel coefficients from uplink channel coefficients for use in selecting the functions g.sub.1(k),g.sub.2(k) of the pre-equalizers to allow different asymmetric traffic configuration characteristics (Pg. 1176, col. 2, lines 39-63, Pg. 1177, col. 1, line 1-28).

(3) With regard to claim 3, claim 3 inherits all the limitations of claim 2. Applicant's Admitted Prior Art further discloses wherein the step of deriving the real channel coefficients from uplink channel coefficients uses training symbols from the uplink channel (Pg. 15, lines 1-13).

(4) With regard to claim 5, claim 5 inherits all the limitations of claim 1. Sampath et al. further discloses wherein the communications system is a frequency-division duplex system and the method includes the further step of deriving the real channel coefficients by sending a set of training symbols to the receive antenna of the mobile terminal, the mobile terminal estimating the real channel coefficients and feeding back channel coefficient information to the base station (Pg. 1175, col. 1, lines 44-54).

(5) With regard to claim 6, claim 6 inherits all the limitations of claim 1.

(6) With regard to claim 7, claim 7 inherits all the limitations of claim 6. Applicant's Admitted Prior Art further discloses in (Fig. 1) a mobile terminal (4, 5) having at least a single receive antenna (4) and a space-time decoder (5) to decode the signals received from the base station.

5. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (Fig. 1) in view of Sampath et al. (IEEE, Pre-Equalization for MIMO Wireless Channels with Delay Spread) as applied to claim 2 above, in further view of Hottinen et al. (US Patent 6,754,286).

With regard to claim 4, claim 4 inherits all the limitations of claim 3. Applicant's Admitted Prior Art in combination with Sampath et al. do not disclose the step of deriving the real channel coefficients from uplink channel coefficients uses blind techniques.

However Hottinen et al. discloses the step of deriving the real channel coefficients from uplink channel coefficients uses blind techniques (col. 13, lines 16-30).

Therefore it would have been obvious to one of ordinary skill in the art to modify the inventions of Admitted Prior Art in combination with Sampath et al. to incorporate the step of deriving the real channel coefficients from uplink channel coefficients uses blind techniques in order to improve the weight resolution and obtain a single feedback mode (Hottinen et al., col. 13, lines 21-25).

6. Claims 8, 9, 31, 36, 37, 42 and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (Fig. 3 and Fig. 4) in view of Gollamudi (US Patent Application 2003/0035490).

(1) With regard to claim 8, Applicant's Admitted Prior Art discloses in (Fig. 3) providing a signal to be transmitted S(n;k); space-time encoding the signal S(n;k) (3) to produce at least two separate signals S.sub.1(n;k),S.sub.2(n;k), each on a respective

output; feeding each output signal S.sub.1(n;k),S.sub.2(n;k) to a transmit processor (8) to produce an output signal X.sub.1(n;k), X.sub.2(n;k) and transmitting the signals X(n;k) over physical channel h(n;k); receiving the received signal Y(n;k) at at least a single receive antenna (4); feeding the received signal Y(n;k) to a receive processor (10) to produce an output signal; and space-time decoding (5) the received signal.

However Applicant's Admitted Prior Art does not disclose a method of achieving combined beamforming and transmit diversity for frequency selective fading channels in a communication system having a base station with multiple transmit antennae and a mobile terminal with at least a single receive antenna, the method comprising the steps of: applying respective selected transmit beamforming weights to each output signal X.sub.1(n;k), X.sub.2(n;k); feeding the respective weighted signals to a signal combiner to perform a summing function of the signals and produce a signal X(n;k) for transmission; feeding the summed signal X(n;k) to each of the multiple transmit antennae for transmission.

However Gollamudi discloses in (Fig. 1) a method of achieving combined beamforming and transmit diversity for frequency selective fading channels in a communication system having a base station with multiple transmit antennae and a mobile terminal with at least a single receive antenna, the method comprising the steps of: applying respective selected transmit beamforming weights to each output signal X.sub.1(n;k), X.sub.2(n;k); feeding the respective weighted signals to a signal combiner (14) to perform a summing function of the signals and produce a signal X(n;k) for

transmission; feeding the summed signal X(n;k) to each of the multiple transmit antennae for transmission (24, 26) (Pg. 2, col. 1, lines 24-34, 40-51).

Therefore it would have been obvious to one of ordinary skill in the art to modify Applicant's Admitted Prior Art to incorporate a method of achieving combined beamforming and transmit diversity for frequency selective fading channels in a communication system having a base station with multiple transmit antennae and a mobile terminal with at least a single receive antenna, the method comprising the steps of: applying respective selected transmit beamforming weights to each output signal X.sub.1(n;k), X.sub.2(n;k); feeding the respective weighted signals to a signal combiner to perform a summing function of the signals and produce a signal X(n;k) for transmission; feeding the summed signal X(n;k) to each of the multiple transmit antennae for transmission to in order to keep up with a quickly changing channel between the base station and a high-speed mobile station (Gollumudi, Pg. 1, col. 2, lines 50-54).

(2) With regard to claim 9, claim 9 inherits all the limitations of claim 8. Applicant's Admitted Prior Art further discloses in (Fig. 4) wherein the respective transmit beamforming weights (11, 12) are selected as the eigenvectors corresponding to the two largest eigenvalues of the downlink channel covariance matrix (DCCM) of the physical channels h(n;k) (Pg. 20, lines 4-10).

(3) With regard to claim 31, claim 31 inherits all the limitations of claim 8. Gollamudi further discloses delaying one of the space-time encoded output signals by

.DELTA..tau.; applying respective selected transmit beamforming weights to the delayed and undelayed signals (Pg. 4, col. 1, lines 56-57, col. 2, lines 16-31).

(4) With regard to claim 36, claim 36 inherits all the limitations of claim 31. Gollamudi further discloses wherein the physical channel h(k) consists of two time-delayed rays h.sub.1(k), h.sub.2(k) with delay .DELTA..tau., the delay .DELTA..tau. is derived from downlink channel information (Pg. 4, col. 2, lines 16-31, 38-41, 51-52, 61-62).

(5) With regard to claim 37, claim 37 inherits all the limitations of claim 31. Gollamudi further discloses wherein the physical channel h(k) consists of two time-delayed rays h.sub.1(k), h.sub.2(k) with delay .DELTA..tau., the delay .DELTA..tau. is derived from uplink channel information (Pg. 4, col. 2, lines 16-31, 38-41, 51-52, 61-62).

(6) With regard to claim 42, claim 42 inherits all the limitations of claims 31 and 36.

(7) With regard to claim 43, claim 43 inherits all the limitations of claims 31 and 37.

7. Claims 12-14, 33-35, 39-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (Fig. 3 and Fig. 4) in view of Gollamudi (US Patent Application 2003/0035490), as applied to claims 8 and 31, in further view of Dogan (US Patent 6,650,881).

(1) With regard to claim 12, claim 12 inherits all the limitations of claim 8. Applicant's Admitted Prior Art in combination with Gollamudi disclose all the limitations of claim 8 above. However Applicant's Admitted Prior Art in combination with Gollamudi do not disclose wherein the physical channel h(n;k) consists of two time-delayed rays, h.sub.1(n;k) and h.sub.2(n;k), with delay .DELTA..tau., the beamforming weights being chosen such that the average transmit SINR function at the base station is maximized for each ray.

However Dogan discloses wherein the physical channel h(n;k) consists of two time-delayed rays, h.sub.1(n;k) and h.sub.2(n;k), with delay .DELTA..tau., the beamforming weights being chosen such that the average transmit SINR function at the base station is maximized for each ray (col. 16, lines 10-33).

Therefore it would have been obvious to one of ordinary skill in the art to modify the inventions of Applicant's Admitted Prior Art in combination with Gollamudi to incorporate wherein the physical channel h(n;k) consists of two time-delayed rays, h.sub.1(n;k) and h.sub.2(n;k), with delay .DELTA..tau., the beamforming weights being chosen such that the average transmit SINR function at the base station is maximized for each ray in order to make the beamformer blind to imperfections in the desired signal (Dogan, col. 16, lines 24-26).

(2) With regard to claim 13, claim 13 inherits all the limitations of claim 8. Dogan further discloses wherein the physical channel h(n;k) consists of two time-delayed rays, h.sub.1(n;k) and h.sub.2(n;k), with delay .DELTA..tau., the beamforming weights being chosen such that the average receive SINR function at the mobile terminal is maximized (col. 16, lines 10-33).

(3) With regard to claim 14, claim 14 inherits all the limitations of claim 8. Dogan further discloses wherein the physical channel h(n;k) consists of two time-delayed rays, h.sub.1(n;k) and h.sub.2(n;k), with delay .DELTA..tau., the beamforming weights for each ray are chosen as the principal eigenvector of the downlink channel covariance matrix (DCCM) corresponding to that ray (col. 16, lines 10-33).

(4) With regard to claim 33, claim 33 inherits all the limitations of claims 31 and 12.

(5) With regard to claim 34, claim 34 inherits all the limitations of claims 31 and 13.

(6) With regard to claim 35, claim 35 inherits all the limitations of claims 31 and 14.

(7) With regard to claim 39, claim 39 inherits all the limitations of claims 31 and 12.

(8) With regard to claim 40, claim 40 inherits all the limitations of claims 31 and 13.

(9) With regard to claim 41, claim 41 inherits all the limitations of claims 31 and 14.

### ***Allowable Subject Matter***

8. Claims 10, 11, 15-23, 29, 32, 38 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The following is a statement of reasons for the indication of allowable subject matter: The instant application discloses a method of achieving transmit diversity gain for frequency selective fading channels in a communication system having a base station with multiple transmit antennae and a mobile terminal with at least a single receive antenna. Prior art references show similar methods but fail to teach: "**wherein the physical channel h(n;k) consists of two time-delayed rays, h.sub.1(n;k) and h.sub.2(n;k), with delay .DELTA..tau., the transmit processors do not add cyclic prefixes and one of the output signals from the transmit processors is delayed by .DELTA..tau. before the respective selected transmit beamforming weight is applied thereto**", as in claim 10, 15; "**wherein the physical channel h(n;k) consists of two time-delayed rays, h.sub.1(n;k) and h.sub.2(n;k), with delay .DELTA..tau., the beamforming weights being chosen such that the delayed signal or its inverse fast Fourier transform (IFFT) only goes through one channel h.sub.1(n;k) between the base station multiple transmit antennae and the receive antenna, whilst the undelayed signal or its IFFT only goes through another channel h.sub.2(n;k) between the base station multiple transmit antennae and the receive antenna, thereby creating two different channels which can be space-time decoded to recover the transmitted signal**", as in claim 11; "**wherein the beamforming weights**

**are chosen such that the delayed signal or its inverse fast Fourier transform (IFFT) only goes through one channel h.sub.1(n;k) between the base station multiple transmit antennae and the receive antenna, whilst the undelayed signal or its IFFT only goes through another channel h.sub.2(n;k) between the base station multiple transmit antennae and the receive antenna, thereby creating two different channels which can be space-time decoded to recover the transmitted signal"**, as in claim 16; **"wherein the beamforming weights being chosen such that the average transmit SINR function at the base station is maximized for each clustered ray"**, as in claim 17; **"wherein the beamforming weights being chosen such that the average receive SINR function at the mobile terminal is maximized"**, as in claim 18; **"wherein the beamforming weights for each clustered ray are chosen as the principal eigenvector of the downlink channel covariance matrix (DCCM) corresponding to that clustered ray"**, as in claim 19; **"estimating a power-delay-DOA profile for channel h(n;k); and, based on the profile: determining the cyclic prefix, .DELTA..psi., to be added by the transmit processors; determining the delay .psi.; diversity order and modulation scheme; and determining the transmit beamforming weights"**, as in claim 20; **"estimating the downlink channel covariance matrix (DCCM) from the uplink channel covariance matrix (UCCM) to construct transmit beamforming weights"**, as in claim 21; **"determining the diversity order and modulation scheme based on the profile"**, as in claim 22; **"wherein the transmit and receive processors are selected from the group consisting of: OFDM, MC-CDMA MC-DS-CDMA and a single carrier system with**

**cyclic prefix"**, as in claim 23 and 29; **"wherein the physical channel h(k) consists of two time-delayed rays h.sub.1(k), h.sub.2(k) with delay .DELTA..tau., the beamforming weights are chosen such that the delayed signal only goes through one ray h.sub.1(k) between the base station multiple transmit antennae and the receive antenna, whilst the undelayed signal only goes through another ray h.sub.2(k) between the base station multiple transmit antennae and the receive antenna"**, as in claim 32 and 38.

9. Claims 24-28, 30, 44 and 45 are allowed.

10. The following is a statement of reasons for the indication of allowable subject matter: The instant application discloses a method of achieving transmit diversity gain for frequency selective fading channels in a communication system having a base station with multiple transmit antennae and a mobile terminal with at least a single receive antenna. Prior art references show similar methods but fail to teach: **"at least two transmit beamformers each receiving an output from a respective transmit processor and applying a transmit beamforming weight thereto"**, as in claim 24 and 44.

### *Conclusion*

11. The prior art made record and not relied upon is considered pertinent to applicant's disclosure:

a. Barratt et al. US Patent 5,592,490 discloses spectrally efficient high capacity wireless communication systems.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Cicely Ware whose telephone number is 571-272-3047. The examiner can normally be reached on Monday – Friday, 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Chin can be reached on 571-272-3056. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9314 for regular communications and 703-872-9314 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-3900.

*Cicely Ware*

cqw
July 7, 2005

STEPHEN CHIN
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